

## **3 INITIAL EVALUATION**

---

This section presents the initial evaluation and assessment of contamination in the study area. The objective of this section is to enable the reader to organize and understand the previous investigations conducted at the facility so as to identify further data gaps and needs during the RI/FS.

### **3.1 SUMMARY OF PREVIOUS INVESTIGATIONS**

Prior studies have been identified and reviewed to identify contaminants associated with the site, and their potential routes of exposure. The investigations reviewed within this section are not meant to be a compilation of all information related to the former Rayonier Mill Site. The investigations discussed below provide the best data for identifying chemicals of potential concern, locations of the chemicals, and exposure pathways. The single largest study of the former Rayonier Mill Site to date was performed by E&E during 1997/98 as part of EPA's hazard scoring effort. Because these data represent the most complete and recent field investigation, the following sections focus primarily on information from this investigation. Other investigations, performed by various agencies, and noted during the scoping phase of the RI, are also included.

#### **3.1.1 SOILS**

Since the late 1980s, there have been three environmental investigations to assess conditions in the imported fill and native soils that comprise the shallow subsurface at the former Rayonier Mill Site. Each of the previous soil investigations is briefly summarized below.

##### **3.1.1.1 Ennis Creek Hydraulic Oil Release**

During a chemical safety audit in May 1989, personnel discovered an oil sheen on Ennis Creek. The sheen appeared to originate from riprap located on the west bank of Ennis Creek, next to the finishing room (Figure 3-1). Subsequent investigations conducted by Rayonier indicated that concentrations of petroleum and polychlorinated biphenyls (PCBs) from past releases of hydraulic fluid from several pulp baling presses in the finishing room were present in underlying shallow soils. Rayonier installed absorbent pads and containment structures to collect the leaking oil. Oil-absorbent booms were also placed in Ennis Creek, and Rayonier installed a recovery system to intercept and collect oil migrating towards Ennis Creek (Foster Wheeler, 1997). A site characterization study, begun in October 1989, identified a free-phase oil plume approximately 160 by 65 feet under the eastern side of the finishing room and extending to Ennis Creek. Based on this study, Rayonier proposed an interim remedial action plan to mitigate oil seepage into Ennis Creek.

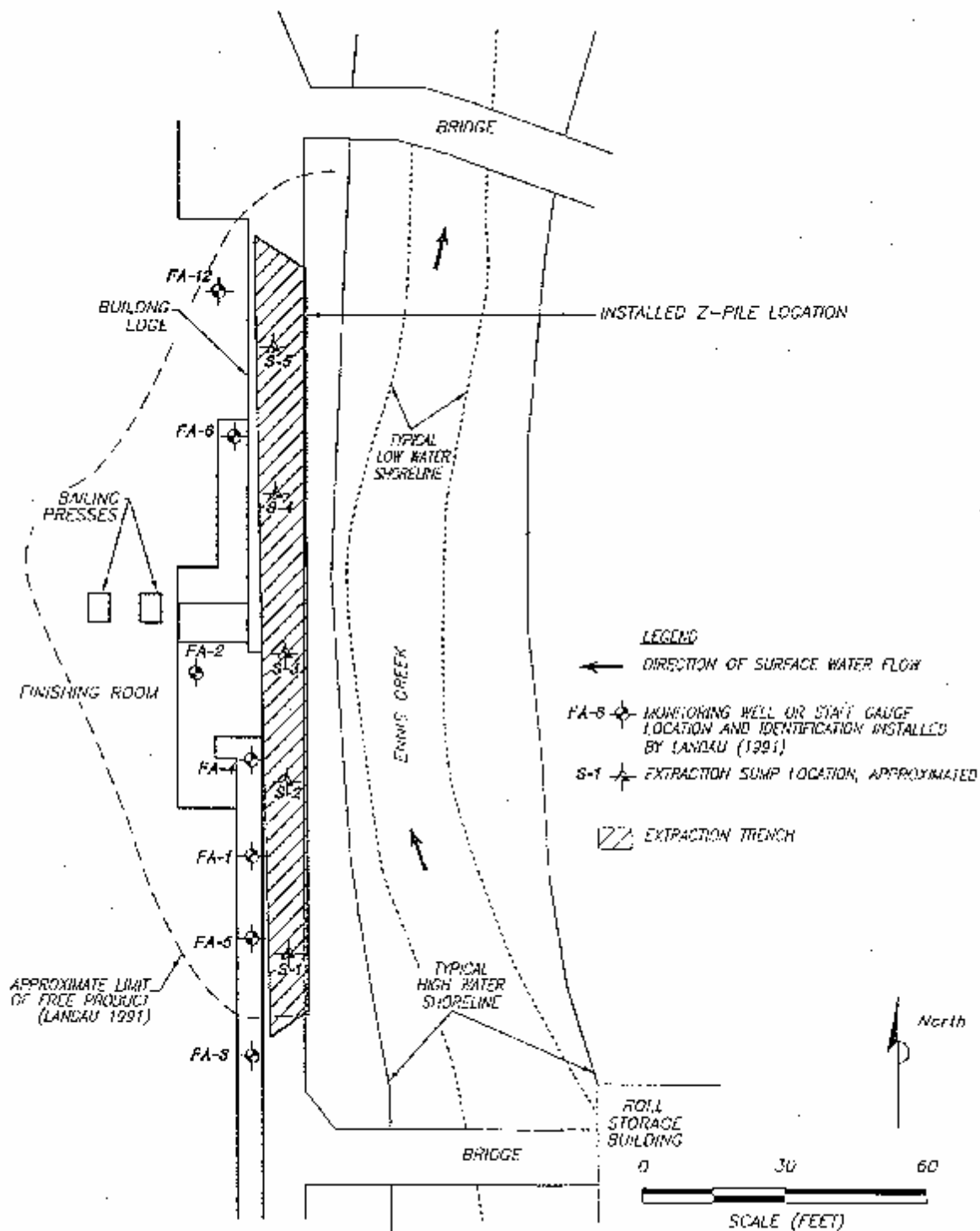


Figure 3-1. Rayonier Pulp Mill Finishing Room Area.

Rayonier began operating an oil recovery system in 1991, using three oil/water extraction wells. In February 1992, Ecology issued a MCTA final enforcement order that required Rayonier to stop the flow of oil into Ennis Creek and remediate oil-contaminated groundwater and soil. In 1993, Rayonier excavated a 160-foot-long, 8-foot-wide, and 8-foot-deep trench along the western side of the sheet pile wall that bordered Ennis Creek (SECOR, 1993). Extraction pumps pumped groundwater through an oil/water separator which then routed the water through the former Rayonier Mill Site's waste treatment system. The recovered hydraulic oil was discharged into a holding tank for off-site disposal.

Soils beneath the finishing room were found to have concentrations of hydraulic oil up to 52,000 mg/kg and concentrations of PCBs up to 56 mg/kg (Ecology, 1992). In 1998, Rayonier entered into an agreed order with Ecology for cleanup of affected soils and groundwater at the finishing room site. The order included a work plan, prepared by SECOR, which called for removal of contaminated soils in the finishing room hydraulic area to meet MCTA Method B cleanup level requirements of 1,000 mg/kg total petroleum hydrocarbons (TPH) and 10 mg/kg PCBs. Contaminated soils in the load center transformer room area were to be removed to meet Toxic Substance Control Act (TSCA) cleanup levels for PCBs (1 mg/kg).

Rayonier removed more than 8,300 tons of soil in the finishing room project area between September and December 1998. An estimated 166,835 pounds of TPH and 27.17 pounds of PCBs were removed with the contaminated soils. Excavation soil samples were analyzed by an on-site mobile laboratory to confirm that MCTA Method B and TSCA cleanup levels were being met. Statistical analysis of the confirmation soil sample data demonstrated compliance with the agreed order (SECOR, 1999). It was not possible to remove soils in the stream bank at that time.

An interim remedial action to remove the sheet pile wall, TPH- and PCB-affected soil/sediment east of the sheetpile wall, and riprap associated with the stream bank was completed in the summer of 2002 (Integral and Foster Wheeler 2003). A total of 1248 tons of TPH- and PCB-affected soil/sediment were removed from the western bank and streambed of Ennis Creek adjacent to the finishing room. In addition, the sheet pile wall, two existing concrete pipe supports, four monitoring wells, two extraction sumps, and protective riprap on the west bank of Ennis creek were removed from the area. The excavation was backfilled with clean graded material and habitat enhancements were made to the shoreline (i.e., shallow sloping shoreline to allow the creek to flow more naturally, anchored roots wads, and revegetation).

Confirmatory sediment samples were collected from the walls and floor of the excavation following completion of the 2002 interim action (Integral and Foster Wheeler 2003). Several confirmatory samples showed detections of TPH above the clean-up criteria. However, the quality of the confirmatory samples was compromised and they were not indicative of sediment quality at the limits of the excavation. A stream

bypass was constructed prior to excavation activities to keep surface water out of the excavation. Excavation of the western portion of the streambed adjacent to the Finishing Room proceeded to three feet below the mudline. Although pumps were used to remove water from the excavation, groundwater and subsurface stream water accumulated in the excavation. An oily sheen was observed on the surface of the water in the excavation. Confirmatory sediment samples collected from the walls and bottom of the excavation were compromised because they were contaminated by the sheen. Delineation sediment samples collected prior to excavation showed contamination to be limited to a relatively small area along the west bank of Ennis Creek adjacent to the Finishing Room. All other delineation samples from the creek had TPH concentrations well below the cleanup levels. It was concluded that further excavation of sediment from the stream was not required.

### **3.1.1.2 Investigation and Remediation at Former Fuel Oil Tank No. 2**

Fuel Oil Tank No. 2, used for storage of No. 6 Bunker C fuel oil for use in the Rayonier mill's boilers, was formerly located on the west side of the mill. It was an aboveground carbon-steel tank with a capacity of 55,000 barrels. The tank was used from 1944 to 1990 and was dismantled in 1993.

Before tank demolition, site investigations in 1989 and 1990 (Landau and Associates, 1990 and 1991) indicated that hydrocarbon contamination was present in the soil and groundwater near the tank. Twenty-eight soil borings were conducted, and thirteen groundwater monitoring wells (GMWs) were installed near the Fuel Oil Tank No. 2 (Figure 3-2).

Remediation activities consisted of excavation and thermal desorption of approximately 1,500 cubic yards (cy) of soil. The treated soils were returned to the original excavation. Confirmation samples from the treated soils indicated MCTA Method A cleanup criteria had been met. Due to accessibility problems, TPH-contaminated soils were left in place near the sump and pipe rack foundation. Rayonier installed an in situ steam injection system with groundwater extraction to enhance petroleum recovery and continue remediation.

An interim action to remove TPH-affected soil above the groundwater table in the area between the former No. 2 fuel oil tank and the recently completed hog fuel pile excavation located approximately 100 feet east of the tank was completed in the summer of 2002 (Integral and Foster Wheeler 2003). A total of 3,042 tons of TPH-affected soil were removed from the area. The excavation was backfilled with concrete rubble and soil.

### **3.1.1.3 Hog Fuel Pile Investigation**

In 1993, Rayonier conducted an investigation to evaluate an area of possible hydrocarbon contamination under the hog fuel pile. The investigation included digging

test pits and sampling soil/wood chip material and groundwater. The samples were submitted for TPH analysis. The test pits showed that the ground surface was actually composed of wood chips that extended 4.5 to 7.5 feet bgs. Debris encountered below the wood chip layer indicated that materials at the base of the test pits were actually fill and not native soil (Landau, 1993).

Analysis of material taken from the test pits indicated hydrocarbon contamination between 5 and 7.5 feet bgs. The analytical report also indicated that the hydrocarbons were being degraded by natural decomposition of the surrounding hog fuel layers. Due to the relatively limited area of contamination (approximately 90 cy, including soil and hog fuel debris), Rayonier chose in situ bioremediation as the remedial alternative. The test pit analysis indicated that TPH concentrations were only slightly above the MCTA cleanup level of 200 mg/kg.

Under the direction of Rayonier (Mr. Jack Anderson, personal communication), Landau and Associates (Landau 2001a and 2001b, Rayonier 2001) conducted a supplemental evaluation of the hog fuel pile in 2001 to assess the suitability of the material for disposal at the Port Angeles Sanitary Landfill. Supplemental sampling of the hog fuel pile material consisted of collecting:

- eight samples for toxicity characteristic leaching procedure (TCLP) analysis including VOCs, SVOCs, pesticides, herbicides, and metals
- sixteen samples for petroleum hydrocarbons (i.e., primarily diesel-range and heavy oil-range petroleum hydrocarbons)
- one sample for VOCs

Samples were collected from throughout the footprint of the former hog fuel pile area and from throughout vertical extent of the hog fuel material (i.e., sampling depths ranged from 0 to 6 feet). Results of the TCLP analysis showed that VOCs, SVOCs, pesticides, and herbicides were not detected in any sample. Barium and cadmium were the only metals detected by TCLP analysis and concentrations were well below those defined in the dangerous waste regulations (WAC 173-303). Total petroleum hydrocarbon concentrations ranged from approximately 400 to 17,000 ppm and are well below the Port Angeles Sanitary Landfill acceptance criteria of 30,000 ppm (Parametrix 1998). Only six VOCs were detected and concentrations were well below those defined in the dangerous waste regulations (WAC 173-303).

Following the 2001 supplemental evaluation, approximately 2700 cubic yards of wood residue was excavated from the base of the hog fuel pile and sent to the Port Angeles Sanitary Landfill for disposal. During the 2002 interim action at the Fuel Oil Tank No. 2 (See Section 3.1.1.2), soil was also excavated from the southwest corner of the 2001 hog fuel pile excavation (Integral and Foster Wheeler 2003). The hog fuel pile excavation was backfilled with concrete rubble stockpiled at the mill site.

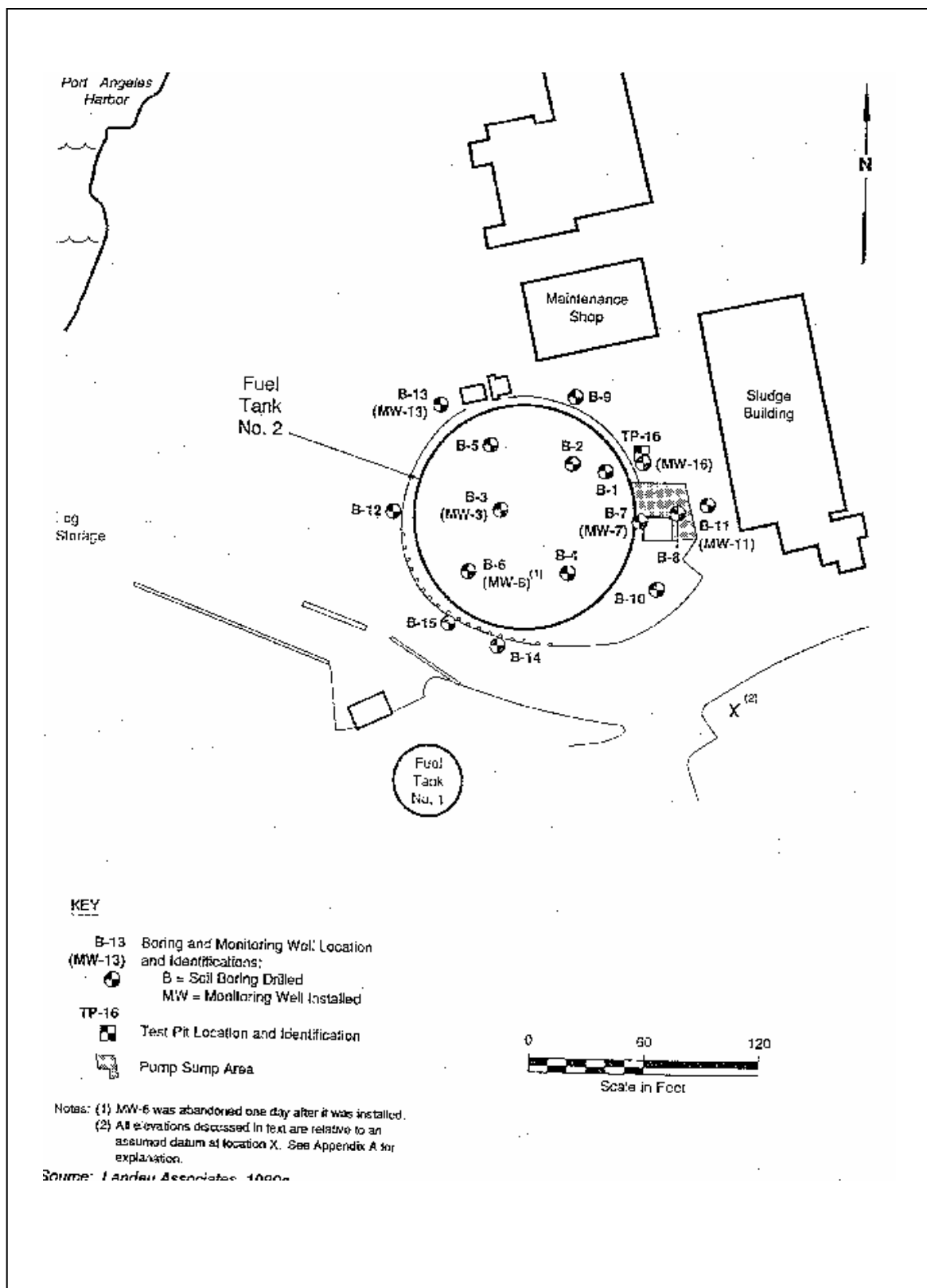


Figure 3-2. Fuel Tank No.2 with Boring and Well Locations.

#### **3.1.1.4 Former Machine Shop Action**

The machine shop was located near the west end of the mill property inside the engineering building. At the time the building was demolished in mid-1999, oil staining was noted both on the wooden floor and on the soils beneath the shop. The wooden flooring was tested for TPH (as diesel and heavy oil) and PCBs in preparation for disposal.

An interim action was planned to address the TPH-affected soil at Former Machine Shop (Foster Wheeler 2002b). The objectives of this action were to remove TPH-affected soils above the groundwater table in the area between the support piers under the former Machine Shop and to clean residual TPH from the surface of the support members. Soil was also screened for the presence of PCBs, metals, and solvents. This interim action was completed in the summer of 2002 (Integral and Foster Wheeler 2003). A total of 970 tons of TPH-affected soil were removed from the area. Concrete supports present in the project area were either left in place and cleaned or removed to a staging area for further characterization and possible disposal. The excavation was backfilled with clean concrete rubble.

#### **3.1.1.5 Spent Sulfite Liquor Lagoon**

The SSL Lagoon was located along the shoreline on the eastern portion of the mill site. During the mill's operations, SSL was produced during the pulping process and recycled as a fuel to power the plant operations. As part of the recovery process, SSL was temporarily pumped to and stored in the SSL Lagoon prior to burning in the recovery boiler. The SSL Lagoon was constructed in 1974 with a 1- to 2-foot,  $10^{-5}$  centimeters per second (cm/sec) permeability clay liner and a 60-mil high density polyethylene (HDPE) floating cover.

Landau Associates (Landau 1998) collected thirteen samples from the clay liner, the berm, and the residual material in the SSL Lagoon in 1997 and analyzed them for metals, SVOCs, and dioxins/furans. Results of these analyses are provided in Section 2.3.6 of the SAP (Volume II) and show that no chemicals were detected above the MTCA industrial cleanup levels, and only arsenic was detected above the MTCA unrestricted land use soil criteria.

The SSL Lagoon was closed in the summer of 2001. The clay liner and associated stained soil located above the groundwater table were excavated and sent to Rayonier's Mt. Pleasant Landfill for use below the synthetic membrane as subgrade fill material for the final cover (Landau 2003). The SSL Lagoon excavation was backfilled and compacted with soil from the berm. Excess berm soil was also sent to the Mt. Pleasant Landfill.

#### **3.1.1.6 Drainage Ditch**

The EPA identified storm drains as one of the potential receptors of contaminants from suspected source areas on the mill site (E&E 1998). A drainage ditch located on the east side of the mill near the Chlorine Dioxide Generator and the Primary Clarifier collected

surface water runoff from the area. During the mill's operations, the ditch collected stormwater from the asphalted areas as well as the occasionally receiving biological solids from the secondary effluent treatment system during its periodical maintenance. Water that collected in the ditch flowed to the southwestern end of the ditch and was pumped to the mill's treatment system. Since shutdown of the mill, the ditch has received only stormwater from the asphalted area.

During the ESI, EPA collected five sediment samples from the drainage ditch and analyzed them for the presence of the full suite of priority pollutant (167 chemicals). A number of metals and organic chemicals, including polynuclear aromatic hydrocarbons (PAHs) and dioxins/furans, were detected in drainage ditch sediment samples at concentrations above background. Rayonier decided to remove the buildup of sediments in the ditch and thus allow for stormwater to be discharged to the adjacent receiving waters. Approximately fifteen cubic yards of soil were removed from the ditch. Following removal of the surface soils, a single composite soil sample was taken from the exposed surface in the ditch near the location of the secondary treatment discharge. Clean fill material from off-site was then placed into the ditch, graded and the ditch was hydroseeded with a native grass mixture.

#### **3.1.1.7 Rayonier Pulp Mill Expanded Site Inspection**

In 1998, EPA conducted an expanded site inspection (ESI) at the former Rayonier Mill Site (E&E, 1998). Thirty-four subsurface soil borings were completed. Fifty-six subsurface soil samples and ninety surface soil samples were collected from the former Rayonier Mill Site, resulting in one hundred forty-six soil samples. The samples were analyzed for the presence of the full suite of priority pollutants (167 chemicals) which included metals, volatile and semivolatile organic compounds, pesticides, PCBs, PAHs, and dioxin/furans. Approximate sample locations are portrayed in Figure 3-3.

Based on historical mill processes, waste handling practices, and the potential presence of hazardous substances or contamination, EPA targeted the following areas as potential contamination sources:

- *Log Yard.* The log yard is mostly underlain by fill material and was used to store logs and stockpile boiler and fly ash before off-site disposal. Both paved and unpaved areas are present.
- *Hog Fuel Pile.* Hog fuel was stored in this unpaved area that is also underlain by fill material. Primary wastewater treatment sludge and wood waste were used as hog fuel and stored here.
- *Bone Yard.* The bone yard is an unpaved area east of the secondary treatment system where used equipment, including electrical transformers, was stored before off-site disposal or reuse.



Approximate Scale in Feet

0 1,200



Figure 3-3. EPA (1998) Expanded Site Inspection Soil Sampling Locations.

- *Facility Buildings.* Many of these buildings were located in the central portion of the former Rayonier Mill Site and were built on fill material. A few were pile-supported. Soil borings were installed near the following: the recovery boiler room, acid plant, digester building, blowpits, screening room, bleach plant, machine room, finishing room, laboratory, chip surge bin, and pre-fab shop.
- *Pre-fab Area/ Chlorine Dioxide Generator.* The pre-fab area was also known as the contractor parking lot. It is unpaved and was used for new equipment storage before installation. The chlorine dioxide generator was directly north of the pre-fab area and was located on pavement. It produced chlorine dioxide for the pulp bleaching process.

The ESI also identified potential receptors for these source areas, including the following:

- *Wastewater Treatment Collection System.* The pumping stations, storm drains and sumps received runoff from the potential source areas, and sediments had accumulated in many of them. The treatment system drained into Outfall 001 and provided a route to receptors in Port Angeles Harbor.
- *Ennis Creek.* The hydraulic oil leaks in the finishing room have contaminated soils and sediments along the west bank of Ennis Creek. Pumping station and sump overflows are also known to have reached the creek.
- *Nearby Residences and Businesses.* Surficial soils at these off-site locations may have been impacted by the deposition of air-borne particulates.

The ESI reported detected and validated analytical results, but made no attempt to compare them to MCTA standards. Instead, concentrations exceeding certain values were highlighted. These values were defined as being equal to or greater than the sample's contract-required quantitation/contract-required detection limit (CRQL/CRDL) and equal to or greater than the background sample's CRQL/CRDL or DL, as appropriate, when the background concentration is below detection limits, or at least three times greater than the background concentration when the background concentration equals or exceeds the detection limit. Using these criteria as a basis, the ESI classified approximately 42 chemicals and compounds of interest in the on-site soils.

### **3.1.2 GROUNDWATER**

Since 1991, 43 GMWs have been installed on the former Rayonier Mill Site to assess groundwater conditions in the shallow water-bearing zone beneath the site and/or to monitor the effectiveness of interim remedial actions (Figure 3-4). During the 1990s, Rayonier conducted groundwater testing as part of interim cleanup actions under State of Washington oversight, as well as several independent groundwater quality surveys. In 1998, EPA tested groundwater in selected site wells as part of the ESI (E&E, 1998).

Each of the previous groundwater investigations is briefly summarized below.

### **3.1.2.1 Groundwater Investigation and Remediation near the Former Fuel Oil Tank No.2**

Fuel Oil Tank No. 2 was an above-ground, riveted, carbon-steel tank with a capacity of 55,000 barrels located on the west side of the former Rayonier Mill Site (the tank was dismantled in 1993). The tank was used from approximately 1944 to 1990 for storage of the No. 6 Bunker C fuel oil used in the former Rayonier Mill Site's boilers.

Subsurface investigations near Fuel Oil Tank No. 2 before demolition of the tank involved drilling 28 soil borings and installing 13 groundwater monitoring wells (Landau, 1990 and Landau, 1991). Four wells (MW-11, MW-19, MW-20, and MW-23) remain in the area (see Figure 3-2).

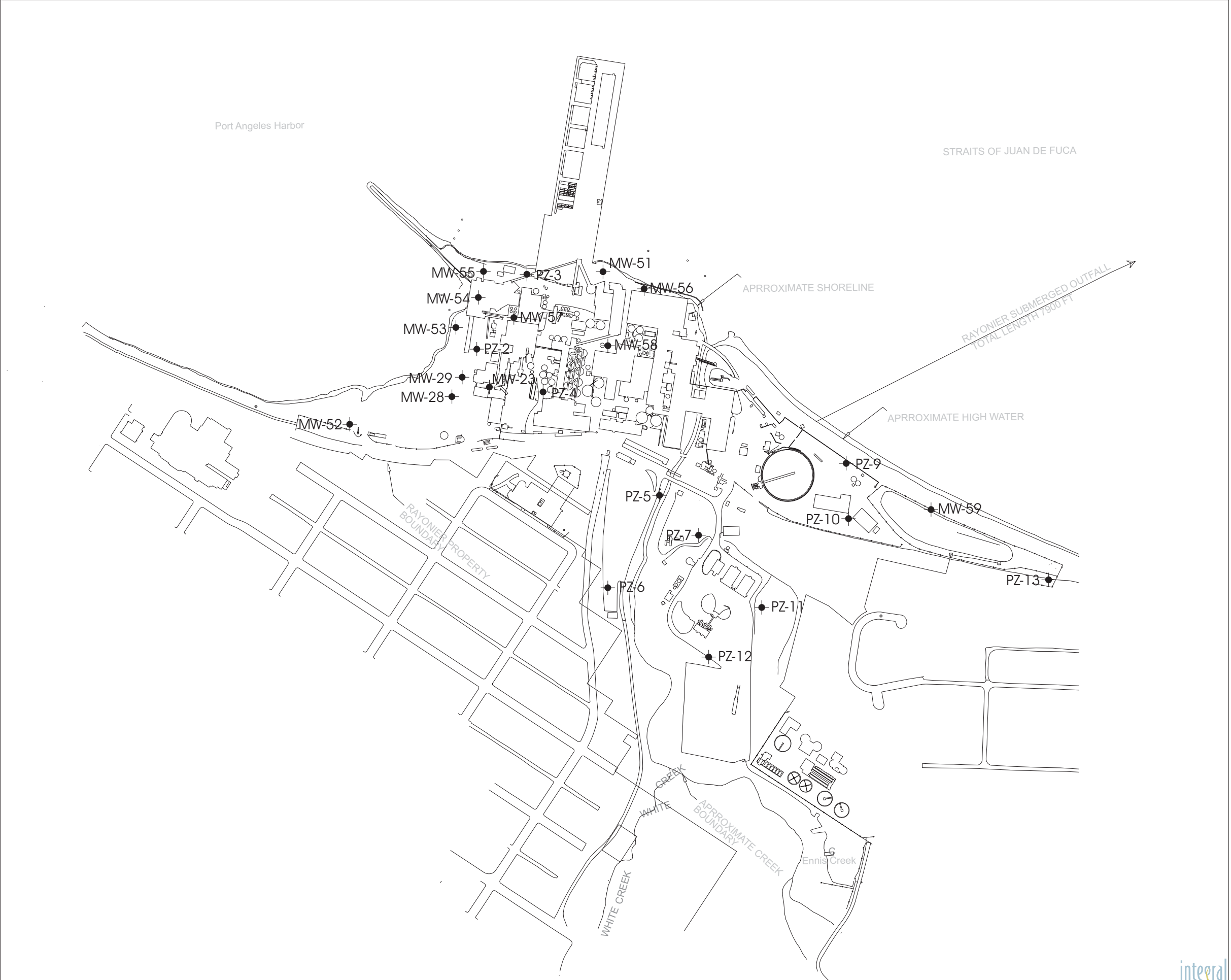
The subsurface investigations revealed petroleum constituents in the soil and groundwater beneath the footprint of the former tank and in an adjacent pump sump area immediately east of the tank. Free-phase petroleum product, apparently up to 2 feet thick, accumulated in wells MW-7 and MW-16, located in the pump sump area. Remedial activities associated with the former No. 2 Fuel Tank consisted of the following:

- The excavation and treatment of approximately 1,500 cy of soil by thermal desorption.
- The installation of an extraction sump with above-ground extraction pumps designed to remove petroleum-impacted groundwater and convey it to the former Rayonier Mill Site's existing wastewater treatment facility.
- The installation of a stream injection system to address petroleum-impacted soils in contact with groundwater in an inaccessible area east of the sump pump to mobilize and remove petroleum constituents from the subsurface.

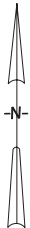
A recent groundwater sampling event in the area of the former Fuel Oil Tank No. 2 occurred in August and September 1997 when wells MW-11, MW-20, MW-23, and MW-29 were sampled (Landau, January 21, 1998). A layer of free-phase petroleum product was present in well MW-11 during this sampling event. Due to the presence of free-phase product, groundwater samples were not collected from well MW-11; however, petroleum product was collected and analyzed for the presence of PCBs. No PCBs were found to be present above the method detection limits (MDLs).

Groundwater samples collected from wells MW-20, MW-23, and MW-29 were analyzed for volatile and semivolatile organic compounds, PCBs, TPH, (Washington TPH-diesel [WTPH-D] extended), and dissolved priority pollutant metals. No exceedances above MTCA Method A cleanup levels (WAC 173-340-720) were found in samples submitted for analysis from wells MW-20, MW-23, and MW-29.





◆ Groundwater Monitoring Well



**Figure 3-4**  
**Remedial Investigation Existing**  
**Groundwater Monitoring Well Locations**



### **3.1.2.2 Investigation and Remediation Activities near the Finishing Room**

An apparent release of oil originating from beneath the finishing room building in the northeast area of the former Rayonier Mill Site near the mouth of Ennis Creek was discovered in May 1989 when Ecology noted an oil sheen on Ennis Creek during an EPA chemical safety audit. Subsequent investigations by Rayonier indicated that the release was a result of hydraulic fluid leakage from several pulp baling presses in the finishing room.

In 1989 and 1990, Landau Associates, Inc., conducted an evaluation of the source and extent of the hydraulic oil contamination and initiated remedial actions (Landau, March 6, 1991). Based on this study, Rayonier identified a free-phase petroleum plume measuring approximately 160 by 65 feet under the eastern portion of the finishing room and extending to Ennis Creek.

In 1992 and 1993, Rayonier installed a sheet pile containment wall with an extraction trench and a groundwater and free-phase product recovery system between Ennis Creek and the finishing room. The extracted groundwater was directed to an oil/water separator and then processed at the Rayonier wastewater treatment facility. Recovered oil was conveyed to an aboveground product storage tank. Remedial activities in the finishing room area are described in an interim action report prepared by SECOR in 1999.

Investigation and remediation activities in the finishing room area have been conducted in accordance with the provisions described in Enforcement Order DE 92TCI029 and Agreed Order DE 98SW-S288, issued to Rayonier by Ecology in 1992 and 1998, respectively. Pursuant to the requirements of the agreed order, quarterly sampling of groundwater from compliance wells FR-1, FR-2, FR-3, and FR-4, installed downgradient of the area, and surface water sampling from Ennis Creek have occurred. Results of groundwater and surface water sampling through the fourth quarter of 1999 indicated concentrations of TPH and PCBs are no longer present above laboratory detection limits (Landau, November 11, 1999).

### **3.1.2.3 Field Investigation Report, ITT Quantitative Environmental Survey Program**

The objective of this 1993 study, performed by HLA (HLA, 1993), was to assess the stratigraphic and hydrogeologic conditions at the former Rayonier Mill Site. It included installing 12 piezometers (PZ-1 through PZ-7, and PZ-9 through PZ-13), measuring water elevations, and assessing the magnitude of any tidal influence on groundwater. No analytical samples were collected during the study. Groundwater was found in a shallow-water bearing zone between 5 and 15 feet bgs under unconfined conditions. Groundwater flow directions were determined to be north towards Port Angeles Harbor.

#### 3.1.2.4 Rayonier Pulp Mill Expanded Site Inspection

As noted above, E&E conducted an ESI in November and December of 1997 (E&E, 1998). The ESI involved collection of samples from potential hazardous substance source areas and from target areas potentially impacted through contaminant migration. Three hundred and one samples were collected from multiple on-site locations, at off-shore points in Port Angeles Harbor, the Strait of Juan de Fuca, and at off-site residences and businesses. Media samples included on-site soils and groundwater, marine and freshwater sediments, and process wastes.

On-site groundwater was sampled in seven piezometers, five monitoring wells (all in the finishing room area), and seven in situ grab samples (using a Geoprobe™). Groundwater samples were analyzed for VOCs and semivolatile organic compounds (SVOCs), PCBs WTPH-D extended, dissolved priority pollutant metals, and pesticides.

The ESI report defined a potential contaminant to be present at an elevated concentration if analytical results met one or a combination of the following criteria:

- The analytical result is equal to or greater than the contract required quantitation limit/contract required detection limit (CRQL/CRDL).
- The analytical result is greater than or equal to the background CRQL/CRDL.
- The analytical result is at least three times greater than the background concentration when the background concentration exceeds the detection limit.

For purposes of the report, the ESI established GMW MW-12 as the former Rayonier Mill Site background well. The chemical constituents that were present in groundwater samples collected from piezometers and GMWs in elevated concentrations, as defined in the ESI, are summarized below (Note: Piezometer locations are shown on Figure 3-4; wells designated “FA” were located on the east side of the Finishing Room and were removed during mill dismantling):

- PZ-2 – None of the analytes tested was present in concentrations considered elevated as defined in the ESI report.
- PZ-3 – The metal manganese (1640 µg/L)\* and the semi-volatile organic compound acenaphthene (25 µg/L) were present in concentrations considered elevated as defined in the ESI report.
- PZ-4 - The metals barium (204 µg/L)\*, chromium (35.4 µg/L)\*, manganese (7,230 µg/L)\*, and zinc (66.8 µg/L)\* were present in concentrations considered elevated as defined in the ESI report.
- PZ-7 - None of the analytes tested was present in concentrations considered elevated as defined in the ESI report.

- PZ-9 - The metals arsenic (36.7 µg/L)\*, chromium (128 µg/L)\*, manganese (3,460 µg/L)\*, and vanadium (696 µg/L)\* were present in concentrations considered elevated as defined in the ESI report.
- PZ-11 - The metal manganese (9,060 µg/L)\* was present in a concentration considered elevated as defined in the ESI report.
- PZ-12 - None of the analytes tested was present in concentrations considered elevated as defined in the ESI report.
- FA-2 - The metal zinc (169 µg/L)\* and the semivolatile organic compound bis(2-ethylhexyl) phthalate (260 µg/L) were present in concentrations considered elevated as defined in the ESI report.
- FA-4 - The metals copper (49.7 µg/L)\*, lead (14.7 µg/L)\*, and zinc (2,080 µg/L)\* and the Aroclor 1260 (28 µg/L) were present in concentrations considered elevated as defined in the ESI report.
- FA-5 - The metals copper (55 µg/L)\*, lead (16.7 µg/L)\*, and zinc (1,090 µg/L)\* were present in concentrations considered elevated as defined in the ESI report.
- FA-9 - The metals lead (3.5 µg/L)\*, zinc (635 µg/L)\*, and the semivolatile organic compound bis(2-ethylhexyl) phthalate (270 µg/L) were present in concentrations considered elevated as defined in the ESI report.
- FA-12 - The metal zinc (286 µg/L)\* and the semivolatile organic compound bis(2-ethylhexyl) phthalate (220 µg/L) were present in concentrations considered elevated as defined in the ESI report.

### 3.1.2.5 Mill Site Groundwater Monitoring

The piezometers installed as part of the 1993 Quantitative Environmental Study (HLA, 1993) were first sampled in 1997 (Landau, 1997) and again after mill closure in 1998 (Landau, 1998a). Selected wells from the former Fuel Oil Tank No. 2 area were also sampled in 1998. Rayonier installed two additional wells in 1998 (Landau, 1998b) near former PZ-1 (MW-52) and between the shoreline and the former equipment maintenance facility (MW-51).

The 1997 Landau Associates study used the MTCA Method A cleanup levels (WAC 173-340) as screening levels for evaluation of the analytical results. Samples were analyzed for VOCs, SVOCs, PCBs, WTPH-D extended, priority pollutant metals, turbidity, asbestos, and indicator parameters identified in the minimum functional standards for solid waste handling (WAC 173-304-490). Results showed no exceedances of screening criteria in any wells except PZ-9. PZ-9 showed exceedances of screening criteria for arsenic and chromium only, at concentrations of 0.10 milligrams per liter (mg/L) and 0.485 mg/L, respectively. For comparison, drinking water standards for arsenic and chromium are 0.05 mg/L and 0.10 mg/L, respectively. Diesel-range TPH was detected in three wells: PZ-3 (0.44 mg/L), PZ-4 (0.40 mg/L), and PZ-9 (0.34 mg/L). No other detections exceeded MTCA Method A screening levels. SVOCs were detected in two wells. Acenaphthene (27 µg/L), fluorene (3.1 µg/L), carbazole (6.8 µg/L), and

fluoranthene (1.1 µg/L) were detected in PZ-3. Naphthalene was detected in PZ-9 at 1.2 µg/L. No detections were reported in any of the samples for asbestos or PCBs.

### **3.1.3 FRESHWATER SEDIMENTS**

Freshwater sediments are characterized on the former Rayonier Mill Site as those sediments that are associated with free-flowing surface waters. Ennis Creek, which runs through the mill complex, is the only source of non-marine freshwater sediments within the site boundary. White Creek converges with Ennis Creek near the southern boundary of the site. Ennis Creek is a snowmelt creek, which exhibits variable flows throughout the year. Surface water elevation variations occur daily at the mouth of Ennis Creek as a result of tidal changes. The section of Ennis Creek that flows through the site is confined to a man-made channel lined with large riprap rock creating a relatively fast-flowing stream during high rainfall events. The mouth of Ennis Creek is tidally influenced and the creek discharges directly into Port Angeles Harbor on the Strait of Juan de Fuca.

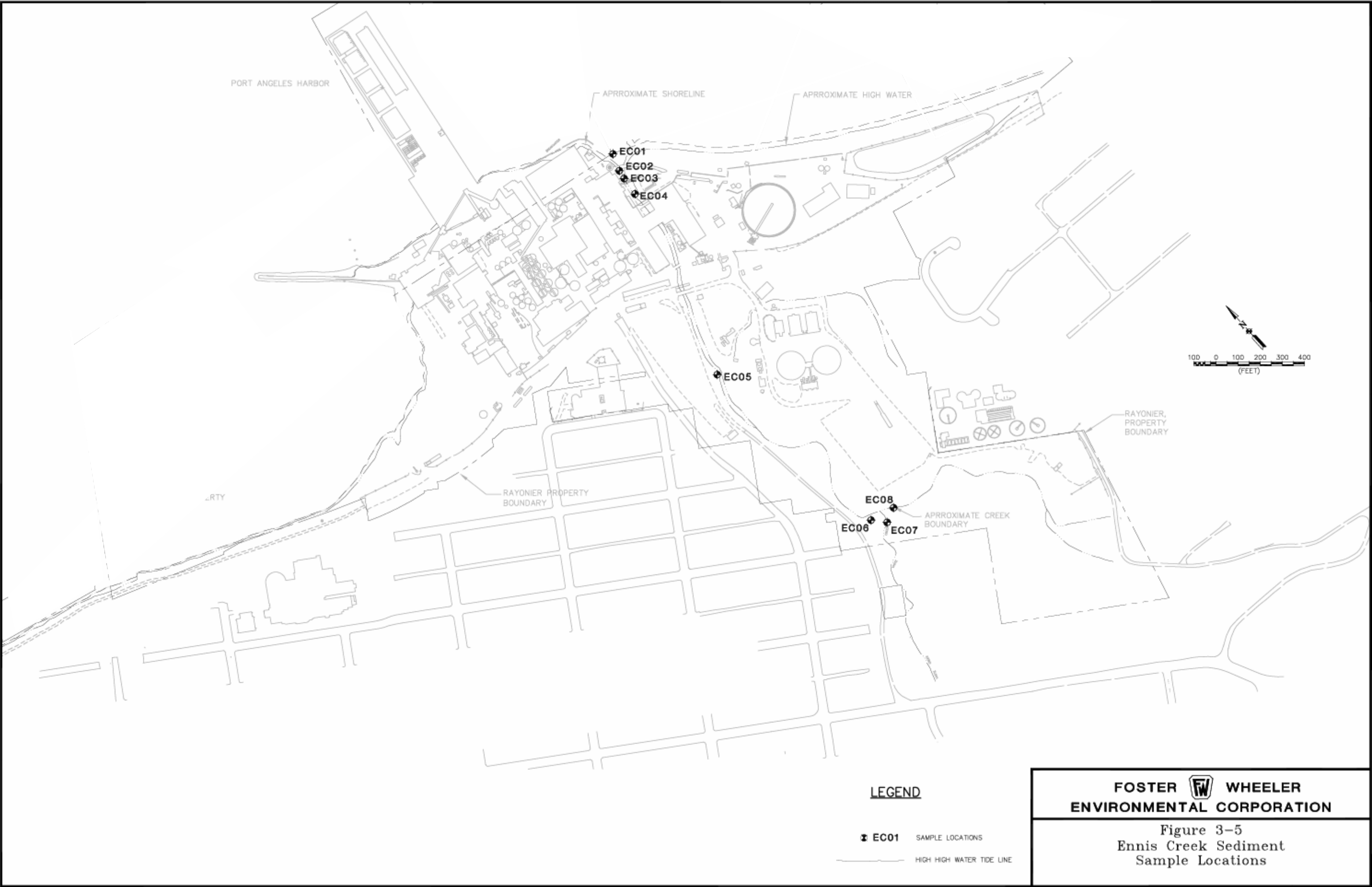
As discussed in Section 3.1.2.2, investigations conducted by Landau Associates (Landau, 1991) identified an area immediately next to and west of Ennis Creek near its outlet to Port Angeles Harbor which contained concentrations of petroleum constituents and low levels of PCBs. The source of the contamination was found to be leaking hydraulic balers in the finishing room. Following the removal of the finishing room during site-wide dismantling activities, excavated approximately 8,300 tons of contaminated soils west of the sheet pile wall (see Figure 3-1). This work was accomplished in the fall of 1998 as an interim action under Agreed Order DE 98SW-S288 with Ecology.

A second interim action conducted in 2002 removed contaminated soil and sediment east of the sheet pile wall (Foster Wheeler 2002b). In addition, the sheet pile wall and protective rip-rap were removed.

Freshwater sediment samples were collected from Ennis Creek during the EPA ESI (E&E 1998) and targeted the area around the finishing room as an area of potential concern. Data available for each of the samples collected from the creek are presented below.

Eight co-located surface water and freshwater sediment samples were collected throughout Ennis Creek (Figure 3-5). Three of the samples were collected upstream of the Rayonier facility and identified as background samples by EPA (E&E 1998). Sample EC07 was located in White Creek above its confluence with Ennis Creek, and sample EC08 was located in Ennis Creek above the Ennis-White Creek confluence. Sample EC06 was located in Ennis Creek below the confluence of the two creeks, but upstream of any probable contamination points of entry from sources on the mill site. Five samples were collected along the creek within the facility boundaries. Sample EC05 was located in the creek near the parking lot area to characterize potential contaminant inputs from runoff from the secondary treatment area drainage ditch. Three sampling stations (i.e., EC02, EC03, and EC04) were located near the former finishing room area and station EC01 was located just beyond the mouth of the creek.





EPA (1998) used the three background freshwater sediment samples collected from Ennis and White creeks for comparison to sediment samples collected from within the site area on Ennis Creek. Table 3-1 summarizes the chemicals detected in freshwater sediment samples collected from Ennis Creek. Several metals were detected at levels above the contract required detection limit (CRDL) among the three background samples. None of these concentrations exceeded the freshwater sediment quality values (FSQV) used in Washington State as guidance values. Sample EC07 was the only one of the three background samples analyzed for dioxin/furans. Three dioxin congeners (i.e., total tetrachlorodibenzo-p-dioxin [TCDD], total heptachlorodibenzo-p-dioxin [HpCDD], and octachlorinated dibenzodioxins [OCDD]) were detected above the CRQL. The dioxin TEQ concentration for this sample was 0.05 nanograms per kilogram (ng/kg).

Concentrations of chemicals of potential concern (COPCs) within the five freshwater sediment samples located within the facility compare well with the background samples. Total organic carbon levels were low, generally less than 1 percent. In Sample EC01, collected just beyond the mouth of the creek, acetone was detected at 64 µg/kg and above the undetected quantity within the background samples. Sample EC03 was the only other sediment sample to contain a target analyte at a concentration that exceeded a background concentration, total TCDF at 1.6 ng/kg. Although two COPCs were elevated relative to the background samples, concentration levels of all detected COPCs from each of the Ennis Creek sediment samples were well below the FSQVs used as guidance to screen freshwater sediments in Washington State. PCBs were not detected in any of the sediment samples, including those collected next to the finishing room. Dioxin TEQ was lower within the facility station (0.01 ng/kg) than at the background location (0.05 ng/kg).

## 3.2 KNOWN AND EXPECTED CONTAMINANTS

On the basis of a compilation and examination of the background information and analytical data from the previous studies presented in Section 3.1, several categories of COPCs were identified as either known or expected to be found in the near-surface soils, subsurface soils, Ennis Creek sediments, and groundwater. They are as follows:

- Toxic inorganics including arsenic, cadmium, chromium, lead, and mercury
- SVOCs, including PAHs
- Dioxins and furans
- PCBs
- Petroleum hydrocarbons

Table 3-1. Summary of Detected Chemicals in Freshwater Sediment Samples Collected from Ennis Creek

Chemical Analyte	Number Samples	Frequency of Detection (%)	Detection Limit Range		Range of Detection		Freshwater Sediment Quality Values (mg/kg)
			Minimum (mg/kg)	Maximum (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)	
Inorganics (mg/kg)							
Aluminum	8	100	--	--	12,900	31,100	No Criteria
Arsenic	8	87.5	1.4	1.4	1.9	5.4	57
Barium	8	100	--	--	17.6	66	No Criteria
Beryllium	8	100	--	--	0.21	0.34	No Criteria
Cadmium	8	62.5	0.07	0.08	0.1	0.95	5.1
Calcium	8	100	--	--	3,920	8,720	No Criteria
Chromium	8	100	--	--	25.8	49.2	260
Cobalt	8	100	--	--	9.7	19.9	No Criteria
Copper	8	100	--	--	40.5	260	390
Iron	8	100	--	--	20,100	37,500	No Criteria
Lead	8	100	--	--	3.3	14.9	450
Magnesium	8	100	--	--	6,330	16,200	No Criteria
Manganese	8	100	--	--	273	500	No Criteria
Nickel	8	100	--	--	24.2	62.4	No Criteria
Potassium	8	100	--	--	607	1,210	No Criteria
Silver	8	75	0.21	0.22	0.2	0.53	6.1
Sodium	8	100	--	--	250	6,020	No Criteria
Vanadium	8	100	--	--	49.3	86.1	No Criteria
Zinc	8	100	--	--	52.2	84.3	410
Volatile Organic Compounds (µg/kg)							
Acetone	8	12.5	12	21	64	64	No Criteria
Semi-volatile Organic Compounds (µg/kg)							
4-Methylphenol	8	12.5	410	500	390	390	No Criteria
Benzo(a)anthracene	8	12.5	410	500	99	99	5,000
Benzo(a)pyrene	8	12.5	410	500	93	93	7,000
Benzo(b)fluoranthene	8	12.5	410	500	130	130	11,000
Benzo(ghi)perylene	8	12.5	410	500	100	100	1,200
Benzo(k)fluoranthene	8	12.5	410	500	64	64	11,000
bis(2-Ethylhexyl)	8	75	410	460	69	640	640
Chrysene	8	12.5	410	500	120		7,400
Dimethyl phthalate	8	12.5	410	500	53	53	No Criteria
Fluoranthene	8	25	410	490	61	320	11,000
Indeno(1,2,3-cd)pyrene	8	12.5	410	500	74	74	730
Phenanthrene	8	12.5	410	500	190	190	5,700
Pyrene	8	12.5	410	500	230	230	9,600
Pesticide/PCBs (µg/kg)							
beta-BHC	8	25	2.1	3.5	0.25	0.56	No Criteria
Endosulfan-II	8	12.5	4.1	6.9	0.66	0.66	No Criteria
gamma-Chlordane	8	25	2.1	2.5	0.39	3	No Criteria
Heptachlor epoxide	8	12.5	2.1	3.5	0.41	0.41	No Criteria
Methoxychlor	8	12.5	21	26	4.5	4.5	No Criteria
Dioxins/Furans (ng/kg)							
TCDFs (total)	2	50	0.33	0.33	1.6	1.6	No Criteria
TCDDs (total)	2	50	0.23	0.23	0.65	0.65	No Criteria
HpCDDs (total)	2	50	2.2	2.2	2.9	2.9	No Criteria
1,2,3,4,6,7,8-HpCDD	2	50	2.2	2.2	2.9	2.9	No Criteria
OCDD	2	100	--	--	14	19	No Criteria
Conventionals (mg/kg)							
Total Organic Carbon	8	100	--	--	1,030	18,500	140,000

ng = nanogram

mg = microgram

<sup>1/</sup> Chemicals and values above the freshwater sediment quality value (FSQV) are indicated in bold.<sup>2/</sup> The FSQV is used as a guidance value in Washington State and corresponds to the "no effects" level.

The following sections specifically identify and discuss the primary chemicals of potential concern (COPCs). In general, these chemicals were identified by comparing the maximum levels of chemicals found in the various media during EPA's expanded site inspection and other relevant studies to screening levels available from Ecology and EPA for each medium. This approach is conservative and will identify chemicals on site for the RI that will not require subsequent remediation efforts.

Chemicals noted in this section are the primary COPCs on site. At times, however, due to lack of data or sampling opportunities, other chemicals may be evaluated and reported. These are specifically detailed in the SAP (Volume II).

All chemicals identified for evaluation by matrix are summarized in Volume II.

### **3.2.1 ON-SITE SOILS**

As noted in Section 3.1.1, EPA collected 56 subsurface soil samples from 34 soil borings and 90 surface soil samples, resulting in 146 samples taken from the former Rayonier Mill Site during 1997. These samples were analyzed for the full suite of priority pollutants (167 chemicals). The EPA data were reviewed according to full EPA contract laboratory program (CLP) validation methods (EPA, 1991a and 1991b). The data quality objectives (DQOs) for precision, accuracy, completeness, representativeness, and comparability were met. Thus, identifying COPCs focused on this data set.

Evaluating chemical concentrations on hazardous waste sites always involves data containing values that are lower than limits deemed reliable enough to report as numerical values. These data points are often reported as nondetected and are referred to as censored data sets. The level of censoring is based on the confidence with which the chemist can evaluate the analytical signal from the noise. The lowest level at which a chemical can be quantified is termed the detection limit. Sixty-one chemicals were deemed "non detect" in the samples collected on site. These chemicals are not considered as COPCs in the RI.

MTCA specifies soil cleanup criteria for the protection of human health and the environment. Two human health exposure scenarios have been developed to determine cleanup criteria within the state: (1) unrestricted land use and (2) industrial land use. Criteria calculated using the unrestricted land use scenario are considered to pose acceptable health risks regardless of activities that may occur on the site in the future. MTCA also provides industrial cleanup levels for sites that are or have been historically industrial and that are planned to be industrial in the foreseeable future. This evaluation compares the data to both criteria; however, the evaluation provided is not intended to identify cleanup standards. Instead, the data review is intended to identify COPCs by comparing the maximum detected concentration of each chemical to the unrestricted (lowest) MTCA soil levels. In addition, Ecology has identified natural background concentrations for metals in soil. The maximum detected concentration

must also exceed the natural background concentration to be identified as a COPC. This identifies chemicals that have to be further evaluated for spatial extent and, in some cases, chemical species. The selection of ecological COPCs is described in Section 5.4.2.1. Table 3-2 lists the COPCs for soil.

The detection limits for the EPA ESI soil data (E&E 1998) were also evaluated and found to be adequate for defining additional sampling requirements. Detection limits for some organic chemicals, such as PAHs, were reported above the MTCA unrestricted soil cleanup levels. However, Tables 2-1 through 2-6 in Volume II show that detected concentrations were reported below the detection limits. For example, in the Bone Yard (Table 2-1, Volume II) PAHs were detected at concentrations ranging from 0.040 to 0.280 mg/kg, while detection limits ranged from 0.370 to 0.460 mg/kg. These detection limits represent the contract required reporting limit (CRQL) – the limit to which an EPA contract lab is required to report a result under the Contract Laboratory Program using EPA's Statement of Work. The method detection limit (MDL) is an estimate of the measured concentration at which there is a 99% confidence that a given analyte is present in a given sample matrix. CRQLs are typically 5 to 10 times above the MDLs. Based on this type of comparison, the soil detection limits for the ESI data were deemed adequate.

Table 3-2. Chemicals of Potential Concern for Soils at the Rayonier Mill Site.

Analyte	Human Health COPC	Ecological COPC
Dioxins/Furans	X	X
PCBs	X	X
PAHs	X	
Pentachlorophenol	X	
Petroleum Hydrocarbons	X	
Antimony		X
Arsenic	X	X
Barium		X
Cadmium	X	X
Chromium	X	X
Cobalt		X
Copper	X	X
Lead	X	X
Manganese		X
Mercury		X
Nickel		X
Selenium		X
Silver		X
Thallium	X	X
Vanadium		X
Zinc		X

### 3.2.2 GROUNDWATER

Twenty-two groundwater monitoring wells at the former Rayonier Mill Site have test data suitable for characterizing groundwater (see Figure 3-4). Rayonier has recently conducted other groundwater testing as part of interim cleanup actions under the state of Washington oversight. Rayonier has also conducted several independent groundwater quality surveys. In 1998, the EPA tested groundwater in selected site wells as part of its ESI (E&E 1998). Through these studies, 51 groundwater samples were collected, and 196 individual chemicals were tested. The results of these studies provide the basis for the selection of the COPCs in groundwater.

Table 3-3 provides a summary of the well sampling events included in the review. These data were selected based on the following rationale:

- Groundwater studies conducted since mill closure in 1997 were included in this evaluation as the conditions are likely to have changed significantly after cessation of operations.
- Data collected from the finishing room area before the 1999 cleanup activities were not included, as the characteristics of this area were significantly altered by removal of more than 8,000 tons of soil during cleanup. Specifically, the data from the finishing room collected during the EPA ESI (samples FA-2, FA-4, FA-5, FA-6, FA-9, and FA-12) were excluded. Data from the wells installed following the cleanup project (FR-1, FR-2, FR-3, FR-4) are included in the data set.
- Data were not included from the Geoprobe TM push-probe borings (well points) installed as part of the EPA ESI (samples LY26GW, LY28GW, PA04GW, HF01GW, HF08GW, and BY058GW). While appropriate to identify soil characteristics and gross groundwater characteristics, the push-probe sample collection protocols are not suitable for use in evaluating groundwater quality data in comparison to screening criteria.
- Unfiltered samples were used for all constituents except inorganics (per WAC 173-340-720 (8) [Ecology, 1996]). Using this guidance, metal concentrations in groundwater were evaluated based on the dissolved fraction using data from filtered samples, and unfiltered metals test results are excluded.

MTCA identifies methods for evaluating groundwater (WAC 173-340-720). Since the water-bearing zone does not currently serve as a drinking water supply, and the former Rayonier Mill Site does not meet Washington State minimum requirements for construction of drinking water supply wells (WAC 173-160-171 [i.e., depth to groundwater and location outside the 100-year floodplain]), drinking water standards are not applicable to the groundwater on site. Since the former Rayonier Mill Site is immediately adjacent to both Port Angeles Harbor (marine water) and Ennis Creek (freshwater), both are potential discharge receptors for site groundwater. Thus,

screening criteria were selected to provide a conservative measure for evaluating site groundwater based on the potential discharge to both marine and freshwater.

Table 3-3. Groundwater Sampling Events Included in the Current Evaluation of Chemicals of Concern

Sampling Event	Sampling Date	Wells Tested <sup>1/</sup>	Chemical Classes Evaluated
EPA ESI	11/97	PZ-2, PZ-3, PZ-4, PZ-7, PZ-9, PZ-11, PZ-12	Volatiles, Semivolatiles, PCBs/Pesticides <sup>2/</sup>
Rayonier ESI Field Split	11/97	PZ-2, PZ-9, PZ-11	General Parameters <sup>3/</sup>
Rayonier Finishing Room Cleanup Monitoring	12/99, 8/99, 5/99, 3/99	FR-1, FR-2, FR-3, FR-4	PCBs, TPH <sup>4/</sup>
Rayonier Limited Sampling 1998 (Rayonier 1998)	8/98	MW-51, MW-52	Volatiles, Semivolatiles, PCBs/Pesticides, Inorganics, TPH, General Parameters
Rayonier Groundwater Survey 1997 (Rayonier 1997)	8/97	PZ-2, PZ-3, PZ-4, PZ-5, PZ-6, PZ-7, PZ-10, PZ-11, PZ-12, PZ-13, MW-11, MW-20, MW-23, MW-29	Volatiles, Semivolatiles, PCBs/Pesticides, Inorganics, TPH, General Parameters
Rayonier Groundwater Survey 1997 (Rayonier 1997)	2/97	PZ-2, PZ-3, PZ-4, PZ-5, PZ-6, PZ-7, PZ-10, PZ-11, PZ-12, PZ-13, MW-11, MW-20, MW-23, MW-29	Volatiles, Semivolatiles, PCBs/Pesticides, Inorganics, TPH, General Parameters

<sup>1/</sup> Well MW-19 has not been sampled during the last 6 years and was removed as part of the 2002 Interim Actions.

<sup>2/</sup> Total metals data are not included per WAC 173-340-720. Finishing room well data are not included as sampling was conducted before area cleanup. Push-probe sample data are not included as protocols are not suitable for groundwater quality criteria comparisons.

<sup>3/</sup> Conventional data are included since the EPA data set did not include these constituents. Other duplicate results are used for data validation.

<sup>4/</sup> Data from compliance monitoring wells installed following the finishing room interim action.

Both state and federal ambient surface water quality standards were selected as they are intended to provide levels protective of aquatic organisms and human health associated with consumption of the aquatic organisms. The screening criteria used for evaluating site groundwater are listed in Table 3-4. Where more than one numerical criterion is available for a chemical, the most stringent criteria were used for the comparison.

Table 3-4. Criteria Used for Groundwater Evaluation

Criteria	Regulatory Citation	Criteria Notes
Human health, State of Washington	MTCA – Method B Surface Water Criteria	Criteria are based on human health exposure from fish consumption.
Human health, Federal	Section 304 of the Clean Water Act, updated by the National Toxics Rule, from National Recommended Water Quality Criteria (EPA 1992, 1995, 1999)	Criteria based on protection of human health exposure from fish consumption.
Aquatic organisms – State of Washington	Ambient Water Quality Criteria – State of Washington (Ecology 1997)	Criteria are based on protection of aquatic organisms (acute and chronic criteria for both marine and freshwater).
Aquatic organisms – federal	Section 304 of the Clean Water Act, updated under the National Toxics Rule from National Recommended Water Quality Criteria	Criteria are based on protection of aquatic organisms (acute and chronic criteria for both marine and freshwater).

Table 3-5 summarizes the results of laboratory analyses conducted during the sampling events listed in Table 3-3. As indicated in the table, 38 of the 196 constituents tested were found above detectable levels in at least one site groundwater sample. The table includes a comparison of the laboratory results for each analyte to the most restrictive regulatory screening criteria shown in Table 3-4. No pesticides, PCBs, or VOCs were found above any of the screening criteria. Five metals (arsenic, chromium, copper, nickel, and selenium) and one SVOC (bis [2-ethylhexyl] phthalate) were found at levels above the screening criteria. These are identified as COCs and are listed in bold type in Table 3-5.

Of the 158 chemicals listed in Table 3-5 that were not detected in the groundwater, 48 had analytical detection limits that were above the screening criteria. While these chemicals were not detected in site groundwater, no conclusions could be made regarding their concentrations compared to the screening criteria due to detection limit issues. These chemicals require further evaluation and are also identified as future COPCs. These chemicals are identified in Table 3-5.

In addition to the chemicals noted above, other chemicals are identified as COPCs for reasons noted below:

- Petroleum hydrocarbons—Diesel-range organics are known to be present in groundwater at the former Rayonier Mill Site. Although no regulatory criteria were identified during the screening, the RI will include a site-specific ecological risk evaluation to identify risks of the chemicals moving into the marine environment.
- Delta BHC—BHC is reported analytically in three forms: beta, delta, and gamma. Although none was detected, the detection limits for beta and gamma exceeded identified screening values. No screening values were found for delta-BHC, but this chemical is retained since it is part of the chemical group.



Table 3-5. Groundwater Sampling Data Summary and Relevant Regulatory Criteria (All values in micrograms chemical per liter water) (Part 1 of 3)

Chemical Analyte	No. of Samples	Detection Frequency	Detection Limit Range		Range of Detections		Minimum Regulatory Criteria	Regulatory Citation
			Min.	Max.	Min.	Max.		
Metals, Dissolved								
Antimony	27	0%	50.00	200.00			4300	Fed Human Health
Arsenic	27	4%	50.00	200.00	100.00	100.00	0.10	WA Human Health
Beryllium	27	0%	1.00	5.00			0.08	WA Human Health
Cadmium	27	0%	2.00	10.00			0.70	WA Aquatic
Chromium	27	11%	5.00	5.00	81.00	1150.00	10	WA Aquatic
Copper	27	30%	2.00	2.00	2.00	30.00	2.40	Fed Aquatic
Iron	27	78%	20.00	20.00	50.00	102000.00		
Lead	27	0%	20.00	100.00			1.41	WA Aquatic
Manganese	27	96%	1.00	1.00	2.00	13900.00		
Mercury	25	0%	0.10	0.50			0.012	WA Aquatic
Nickel	27	4%	10.00	50.00	10.00	10.00	8.20	WA Aquatic
Selenium	27	41%	50.00	50.00	50.00	300.00	5.00	WA Aquatic
Silver	27	0%	3.00	20.00			1.90	WA Aquatic
Thallium	27	0%	50.00	200.00			1.56	WA Human Health
Zinc	27	44%	4.00	20.00	5.00	24.00	66.83	WA Aquatic
Pesticides/PCBs								
4,4'-DDD	7	0%	0.10	5.00			0.00050	WA Human Health
4,4'-DDE	7	0%	0.10	5.00			0.00036	WA Human Health
4,4'-DDT	7	0%	0.10	5.00			0.00036	WA Human Health
Aldrin	7	0%	0.05	2.50			0.00008	WA Human Health
Alpha-BHC	7	0%	0.05	2.50			0.0079	WA Human Health
Alpha-Chlordane	7	0%	0.05	2.50			0.0006	Fed Human Health
Aroclor-1016	48	0%	0.10	3900.00			0.014	Fed Aquatic
Aroclor-1221	48	0%	0.20	7800.00			0.014	Fed Aquatic
Aroclor-1232	48	0%	0.10	3900.00			0.014	Fed Aquatic
Aroclor-1242	48	0%	0.10	3900.00			0.014	Fed Aquatic
Aroclor-1248	48	0%	0.10	3900.00			0.014	Fed Aquatic
Aroclor-1254	48	0%	0.10	3900.00			0.014	Fed Aquatic
Aroclor-1260	48	0%	0.10	3900.00			0.014	Fed Aquatic
Total PCBs	16	0%	0.10	1.00			0.00017	Fed Human Health
Beta-BHC	7	0%	0.05	2.50			0.028	WA Human Health
Delta-BHC	7	0%	0.05	2.50				
Dieldrin	7	0%	0.10	5.00			0.00014	Fed Human Health
Endosulfan I	7	0%	0.05	2.50			0.0087	WA Aquatic
Endosulfan II	7	0%	0.10	5.00			0.0087	WA Aquatic
Endosulfan sulfate	7	0%	0.10	5.00			2.00	Fed Human Health
Endrin	7	0%	0.10	5.00			0.0023	WA Aquatic
Endrin Aldehyde	7	0%	0.10	5.00			0.81	Fed Human Health
Endrin Ketone	7	0%	0.10	5.00				
Gamma-BHC (Lindane)	7	0%	0.05	2.50			0.04	WA Human Health
Gamma-Chlordane	7	0%	0.05	2.50			0.0040	WA Aquatic
Heptachlor	7	0%	0.05	2.50			0.00013	WA Human Health
Heptachlor epoxide	7	0%	0.05	2.50			0.000064	WA Human Health
Methoxychlor	7	0%	0.50	25.00			0.030	Fed Aquatic
Toxaphene	7	0%	5.00	250.00			0.00020	Fed Aquatic
Organic, Semi-Volatiles								
1,2,4-Trichlorobenzene	7	0%	10.00	10.00			227	WA Human Health
1,2-Dichlorobenzene	34	0%	1.00	10.00			4200	WA Human Health
1,3-Dichlorobenzene	34	0%	1.00	10.00			2600	Fed Human Health
1,4-Dichlorobenzene	34	0%	1.00	10.00			4.86	WA Human Health
2,2'-oxybis(1-Chloropropane)	7	0%	10.00	10.00				
2,2'-Oxybis(2-chloropropane)	27	0%	1.00	1.00			42000	WA Human Health
2,4,5-Trichlorophenol	34	0%	5.00	25.00				
2,4,6-Trichlorophenol	34	0%	5.00	10.00			3.93	WA Human Health
2,4-Dichlorophenol	34	0%	3.00	10.00			790	Fed Human Health
2,4-Dimethylphenol	34	0%	3.00	10.00			191	WA Human Health
2,4-Dinitrophenol	34	0%	10.00	25.00			553	WA Human Health
2,4-Dinitrotoluene	34	0%	5.00	10.00			1360	WA Human Health
2,6-Dinitrotoluene	34	0%	5.00	10.00				
2-Chloronaphthalene	34	0%	1.00	10.00				
2-Chlorophenol	34	0%	1.00	10.00			96.70	WA Human Health
2-Methyl-4,6-dinitrophenol	34	0%	10.00	25.00			765	Fed Human Health
2-Methylnaphthalene	34	0%	1.00	10.00				
2-Methylphenol	34	0%	2.00	10.00				
2-Nitroaniline	34	0%	5.00	25.00				
3,3'-Dichlorobenzidine	34	0%	5.00	10.00			0.046	WA Human Health
3-Nitroaniline	34	0%	6.00	25.00				
4-Bromophenyl phenyl ether	34	0%	1.00	10.00				
4-Chloro-3-methylphenol	34	0%	2.00	10.00				
4-Chloroaniline	34	0%	3.00	10.00				

Table 3-5. Groundwater Sampling Data Summary and Relevant Regulatory Criteria (All values in micrograms chemical per liter water) (Part 2 of 3)

Chemical Analyte	No, of Samples	Detection Frequency	Detection Limit Range		Range of Detections		Minimum Regulatory Criteria	Regulatory Citation
			Min.	Max.	Min.	Max.		
Organic, Semi-Volatiles, continued . . .								
4-Chlorophenylphenyl ether	34	0%	1.00	10.00				
4-Methylphenol	34	0%	1.00	10.00				
4-Nitrophenol	34	0%	5.00	25.00				
Acenaphthene	34	21%	1.00	10.00	3.70	27.00	643	WA Human Health
Acenaphthylene	34	0%	1.00	10.00				
Anthracene	34	0%	1.00	10.00			25900	WA Human Health
Benzo(a)anthracene	34	0%	1.00	10.00			0.030	WA Human Health
Benzo(a)pyrene	34	0%	1.00	10.00			0.030	WA Human Health
Benzo(b)fluoranthene	34	0%	1.00	10.00			0.030	WA Human Health
Benzo(g,h,i)perylene	34	0%	1.00	10.00				
Benzo(k)fluoranthene	34	0%	1.00	10.00			0.030	WA Human Health
Benzoic Acid	27	0%	10.00	10.00				
Benzyl Alcohol	27	0%	5.00	5.00				
bis(2-Chloroethoxy)methane	34	0%	1.00	10.00				
bis(2-Chloroethyl) ether	34	0%	2.00	10.00			0.85	WA Human Health
bis(2-Ethylhexyl) phthalate	34	32%	1.00	10.00	2.20	13.00	3.56	WA Human Health
Butyl benzyl phthalate	34	0%	1.00	10.00			1250	WA Human Health
Carbazole	34	15%	1.00	10.00	1.80	7.00		
Chrysene	34	0%	1.00	10.00			0.03	WA Human Health
Dibenzo(a,h)anthracene	34	0%	1.00	10.00			0.00	WA Human Health
Dibenzofuran	34	9%	1.00	10.00	1.20	2.00		
Diethyl phthalate	34	0%	1.00	10.00			28400	WA Human Health
Dimethyl phthalate	34	0%	1.00	10.00			72000	WA Human Health
Di-n-butyl phthalate	34	3%	1.00	10.00	1.30	1.30	2910	WA Human Health
Di-n-octyl Phthalate	34	0%	1.00	10.00				
Fluoranthene	34	12%	1.00	10.00	1.00	2.00	90.2	WA Human Health
Fluorene	34	18%	1.00	10.00	1.10	4.20	3460	WA Human Health
Hexachlorobenzene	34	0%	1.00	10.00			0.00	WA Human Health
Hexachlorobutadiene	34	0%	2.00	10.00			29.90	WA Human Health
Hexachlorocyclopentadiene	34	0%	5.00	10.00			4180	WA Human Health
Hexachloroethane	34	0%	2.00	10.00			5.33	WA Human Health
Indeno(1,2,3-cd)pyrene	34	0%	1.00	10.00			0.03	WA Human Health
Isophorone	34	0%	1.00	10.00			600	Fed Human Health
Naphthalene	34	3%	1.00	10.00	1.50	1.50	9880	WA Human Health
Nitrobenzene	34	0%	1.00	10.00			449	WA Human Health
N-Nitroso-di-n-propylamine	34	0%	2.00	10.00			0.82	WA Human Health
N-Nitrosodiphenylamine	34	0%	1.00	10.00			9.73	WA Human Health
o-Nitrophenol	34	0%	5.00	10.00				
Pentachlorophenol	34	0%	5.00	25.00			4.91	WA Human Health
Phenanthrene	34	6%	1.00	10.00	1.00	1.00		
Phenol	34	0%	2.00	10.00			1100000	WA Human Health
p-Nitroaniline	34	0%	5.00	25.00				
Pyrene	34	6%	1.00	10.00	1.00	1.00	2590	WA Human Health
Organic, Volatiles								
1,1,1,2-Tetrachloroethane	27	0%	1.00	9.00				
1,1,1-Trichloroethane	34	0%	1.00	10.00			417000	WA Human Health
1,1,2,2-Tetrachloroethane	34	0%	1.00	10.00			6.48	WA Human Health
1,1,2-Trichloroethane	34	0%	1.00	10.00			25.30	WA Human Health
1,1,2-Trichlorotrifluoroethane	27	0%	2.00	18.00				
1,1-Dichloroethane	34	6%	1.00	10.00	1.90	3.20		
1,1-Dichloroethene	34	0%	1.00	10.00			1.93	WA Human Health
1,1-Dichloropropene	27	0%	1.00	9.00				
1,2,3-Trichlorobenzene	27	0%	5.00	45.00				
1,2,3-Trichloropropane	27	0%	1.00	9.00				
1,2,4-Trichlorobenzene	38	0%	1.00	45.00			227	WA Human Health
1,2,4-Trimethylbenzene	27	0%	1.00	9.00				
1,2-Dibromo-3-chloropropane	27	0%	5.00	45.00				
1,2-Dibromoethane	27	0%	1.00	9.00				
1,2-Dichlorobenzene	27	0%	1.00	9.00			4200	WA Human Health
1,2-Dichloroethane	34	0%	1.00	10.00			59.4	WA Human Health
1,2-Dichloropropane	34	0%	1.00	10.00			23.2	WA Human Health
1,3,5-Trimethylbenzene	27	0%	1.00	9.00				
1,3-Dichlorobenzene	27	0%	1.00	9.00			2600.00	Fed Human Health
1,3-Dichloropropane	27	0%	1.00	9.00			18.9	WA Human Health
1,4-Dichlorobenzene	27	0%	1.00	9.00			4.86	WA Human Health
2,2-Dichloropropane	27	0%	1.00	9.00				
2-Butanone	27	4%	5.00	45.00	10.00	10.00		
2-Chloroethylvinylether	27	0%	5.00	45.00				
2-Chlorotoluene	27	0%	1.00	9.00				
2-Hexanone	27	0%	5.00	45.00				
4-Chlorotoluene	27	0%	1.00	9.00				
4-Methyl-2-Pentanone	27	0%	5.00	45.00				
Acetone	27	7%	5.00	45.00	5.70	28.00		
Acrolein	27	0%	50.00	450.00			780	Fed Human Health

Table 3-5. Groundwater Sampling Data Summary and Relevant Regulatory Criteria (All values in micrograms chemical per liter water) (Part 3 of 3)

Chemical Analyte	No. of Samples	Detection Frequency	Detection Limit Range		Range of Detections		Minimum Regulatory Criteria	Regulatory Citation
			Min.	Max.	Min.	Max.		
Organic, Volatiles, continued . . .								
Acrylonitrile	27	0%	5.00	45.00			0.40	WA Human Health
Benzene	34	0%	1.00	10.00			43	WA Human Health
Bromobenzene	27	0%	1.00	9.00				
Bromochloromethane	27	0%	1.00	9.00				
Bromodichloromethane	34	0%	1.00	10.00			22	Fed Human Health
Bromoethane	27	0%	2.00	18.00				
Bromoform	34	0%	1.00	10.00			219	WA Human Health
Bromomethane	33	0%	2.00	18.00			968	WA Human Health
Carbon Disulfide	34	3%	1.00	10.00	2.00	2.00		
Carbon Tetrachloride	34	0%	1.00	10.00			2.66	WA Human Health
Chlorobenzene	34	0%	1.00	10.00			5030	WA Human Health
Chloroethane	34	0%	2.00	18.00				
Chloroform	34	0%	1.00	10.00			283	WA Human Health
Chloromethane	34	0%	2.00	18.00			133	WA Human Health
cis-1,2-Dichloroethene	34	3%	1.00	10.00	1.30	1.30		
Cis-1,3-Dichloropropene	34	0%	1.00	10.00				
Dibromochloromethane	34	0%	1.00	10.00			20.6	WA Human Health
Dibromomethane	27	0%	1.00	9.00				
Ethylbenzene	34	0%	1.00	10.00			6910	WA Human Health
Hexachlorobutadiene	27	0%	5.00	45.00			29.9	WA Human Health
Isopropylbenzene	27	0%	1.00	9.00				
m+p Xylenes	27	0%	1.00	9.00				
Methyl Iodide	27	0%	1.00	9.00				
Methylene Chloride	34	6%	2.00	18.00	42.00	42.00	960	WA Human Health
Naphthalene	27	22%	1.00	45.00	1.20	20.00		
N-Butylbenzene	27	0%	1.00	9.00				
n-Propylbenzene	27	0%	1.00	9.00				
o-Xylene	27	0%	1.00	9.00				
P-Isopropyltoluene	27	0%	1.00	9.00				
Sec-Butylbenzene	27	0%	1.00	9.00				
Styrene	34	0%	1.00	10.00				
Tert-Butylbenzene	27	0%	1.00	9.00				
Tetrachloroethene	34	0%	1.00	10.00			4.15	WA Human Health
Toluene	34	21%	1.00	10.00	1.00	49.00	48500	WA Human Health
trans-1,2-Dichloroethene	27	0%	1.00	9.00			32800	WA Human Health
trans-1,3-Dichloropropene	34	0%	1.00	10.00				
trans-1,4-Dichloro-2-butene	27	0%	5.00	45.00				
Trichloroethene	34	3%	1.00	10.00	1.00	1.00	55.60	WA Human Health
Trichlorofluoromethane	27	0%	2.00	18.00				
Vinyl Acetate	27	0%	5.00	45.00				
Vinyl Chloride	34	0%	2.00	18.00			2.92	WA Human Health
Xylene (Total)	7	0%	10.00	10.00				
Petroleum								
Diesel	39	28%	250.00	10000.00	250.00	840.00		
Gasoline	16	0%	0.25	10000.00				
Heavy Oil	39	0%	500.00	25000.00				
General Physical Parameters								
Ammonia	30	97%	1.22	1.22	52.29	68096.00	22	WA AWQC
Chemical Oxygen Demand	11	100%			6100.00	7600000.00		
Chloride	30	100%			5700.00	360000.00		
Field pH	28	100%			5.99	11.98	11	WA AWQC
Nitrate (ug-N/L)	27	81%	10.00	200.00	30000.00	30000.00		
Nitrate + Nitrite (ug-N/L)	30	57%	10.00	200.00	30000.00	30000.00		
Nitrite (ug-N/L)	30	57%	10.00	100.00	30000.00	30000.00		
Sulfate	30	100%			23000.00	1000000.00		
Total Organic Carbon	27	96%	1500.00	1500.00	2200.00	7300000.00		
Tannins & Lignins	14	100%			76.00	1130000.00		

**Table Key**

Italics - Detection limit value exceeds applicable regulatory screening criteria

Bold - Detected concentration exceeds applicable regulatory screening criteria

WA Aquatic - Ambient water quality criteria (chronic) for fresh and marine waters, Chapter 173-201A Washington Administrative Code, State of Washington Department of Ecology 1997

Fed Aquatic - Federal National Toxics Rule ambient water quality criteria (chronic) for fresh and marine waters from National Recommended Water Quality Criteria under Section 304(a) of the Clean Water Act; Federal Register 12/22/92, 05/04/95, and 11/09/99

WA Human Health - State of Washington human health criteria based on consumption of aquatic organisms, derived from Chapter 173-340-730(3)(a)(A&amp;B) (Method B), State of Washington Model Toxics Control Act; Ecology 1986

Fed Human Health - Federal National Toxics Rule human health criteria based on consumption of aquatic organisms, from National Recommended Water Quality Criteria; Federal Register 12/22/92, 05/04/95, and 11/09/99

### **3.3 CONCEPTUAL SITE MODEL**

The conceptual site model for the former Rayonier Mill Site identifies the primary contaminant sources, release mechanisms, transport mechanisms, secondary contaminant sources, potential pathways, and exposure routes. Existing chemical data, approximations of physical transport processes occurring at the former Rayonier Mill Site, and identification of potential human and ecological receptors associated with the former Rayonier Mill Site were used to develop the model. This model helped identify and explain the fate and transport behavior of the chemicals unique to the former Rayonier Mill Site. These data were used to identify the additional data needs that are the focus of this Work Plan.

The model first identifies the primary contaminant sources and then describes the release mechanism from the sources into the receiving environmental media. Using physical transport processes, the migration of potential contaminants through media and the subsequent release mechanisms are summarized. This results in the identification of potentially contaminated media to which receptors are most likely to be exposed (exposure media). Once the exposure media are identified, the specific human and ecological receptors are incorporated into the model, completing the exposure pathway.

The conceptual site model brings together multiple environmental and anthropogenic variables to formulate an understanding of the potential pathways of contaminant movement that may exist at the former Rayonier Mill Site. The model also brings together the physical descriptions of the environment, the extent of the potential contamination, the fate and transport processes, and the potential routes by which human and ecological receptors are exposed to contaminants. In general, the former Rayonier Mill Site model consists of sequential steps that trace potential contaminants from the primary sources to the final receptors (human and ecological).

Figure 3-6 shows the uplands conceptual site model for the terrestrial portion of the former Rayonier Mill Site that includes both on-site and adjacent off-site areas. Figure 3-7 shows the marine conceptual site model for the aquatic portion of the former Rayonier Mill Site that includes Ennis Creek and Port Angeles Harbor.

#### **3.3.1 PRIMARY CONTAMINANT SOURCES**

As summarized in Section 2.1 above, the former Rayonier Mill Site used an ammonia-based acid sulfite process for the production of dissolving grade pulps. Wood chips were combined with fortified ammonium bisulfate cooking liquor produced in the acid plant and treated at high temperature and pressure in the digesters. The cellulose fibers (pulp) produced in the digesters were transferred to blow pits and then to red stock washers where the spent cooking liquor was recovered. The pulp was then sent to the

bleach plant where chlorine, sodium hydroxide, hydrogen peroxide, sodium hypochlorite, and chlorine dioxide were used to remove noncellulose wood components. The pulp was then passed through several washers before being dried and packaged. The plant was powered by a recovery boiler, a hog fuel boiler, and two auxiliary power boilers that used hog fuel (wood waste), combustible solid process residues, and Bunker C fuel oil as energy sources. Before 1972, mill wastewater and stormwater were discharged directly into five nearshore outfalls in Port Angeles Harbor. After 1972, mill effluents were conveyed to primary and secondary treatment systems before being discharged through deep water outfall 001.

The primary sources for potential contaminants have been identified as originating from materials used or coincidentally produced at mill processes, including fuel and hydraulic oils, solvents, and mill process chemicals. Six potential sources have been identified:

- *Ash from the boilers.* The primary source of ash was the No. 6 hog fuel boiler air pollution control system, which generated fly ash. The chemical classes generally associated with hog fuel/wood waste ash are metals and dioxins/furans.
- *Fuel oil leaks and spills from storage tanks, boiler and electrical power operations, and other activities.* The chemical classes generally associated with fuel oil are petroleum hydrocarbons, SVOCs, PCBs, and metals.
- *Gasoline, diesel, paint, and solvent leaks and spills from various workshops and process areas.* The chemical classes associated with these sources are petroleum hydrocarbons, VOCs, SVOCs, and metals, especially lead.
- *Bark and wood debris.* Bark and wood debris have accumulated in log rafting areas in the log pond potentially causing an oxygen limiting condition.
- *Historic process discharges.*
- *Other off-site sources.* Port Angeles is an important urban center on the Olympic Peninsula. It has attracted residential, commercial, and industrial development. A variety of potential sources exists within the area. These sources may have contributed to contamination of the terrestrial environment on the former Rayonier Mill Site and adjacent land and of Port Angeles Harbor. For example, stack emissions from other facilities in Port Angeles may be potential sources of dioxins/furans found in soils in the area, and discharges from industrial or municipal wastewater treatment facilities may have contributed to the presence of contaminants in Port Angeles Harbor.

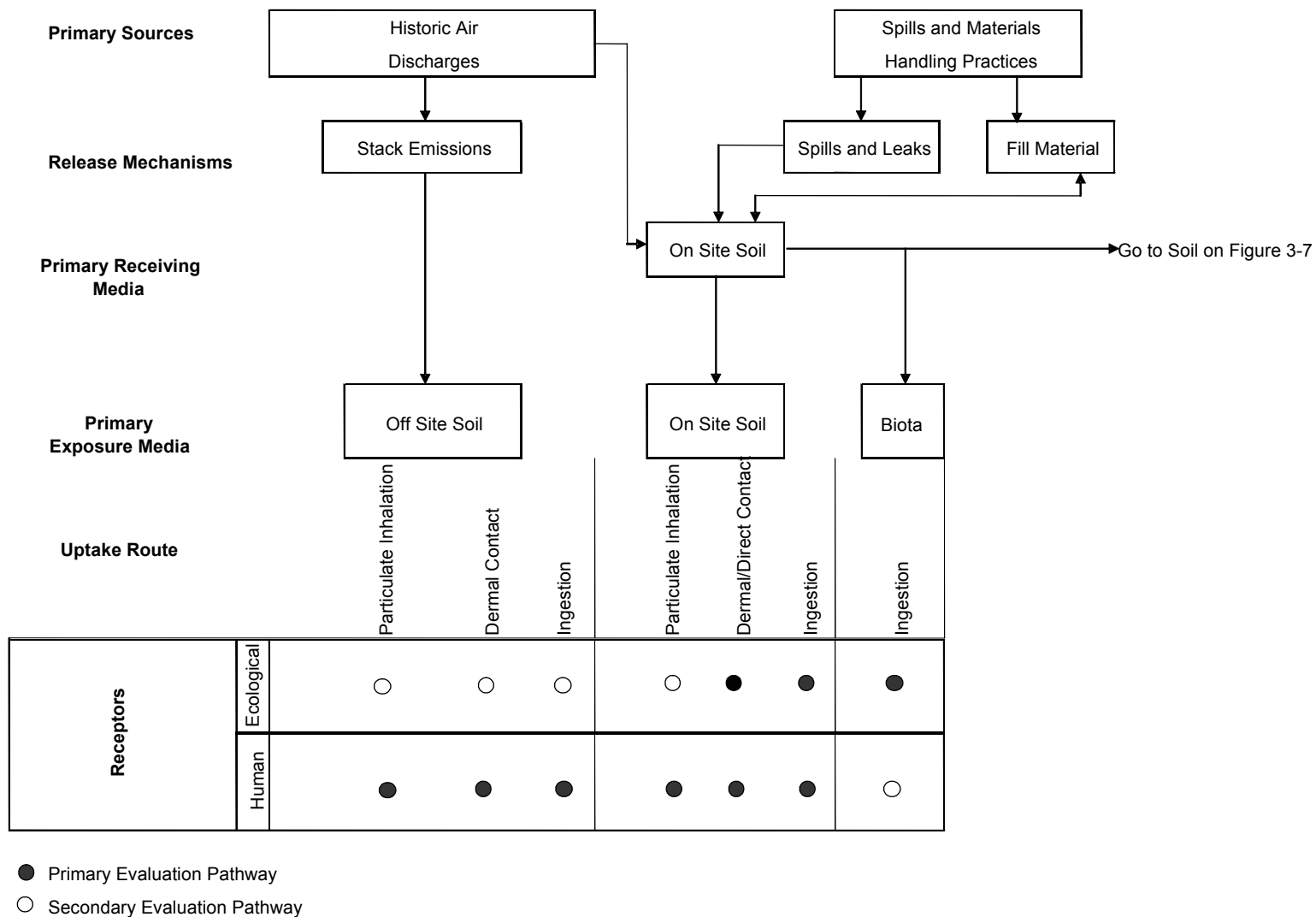
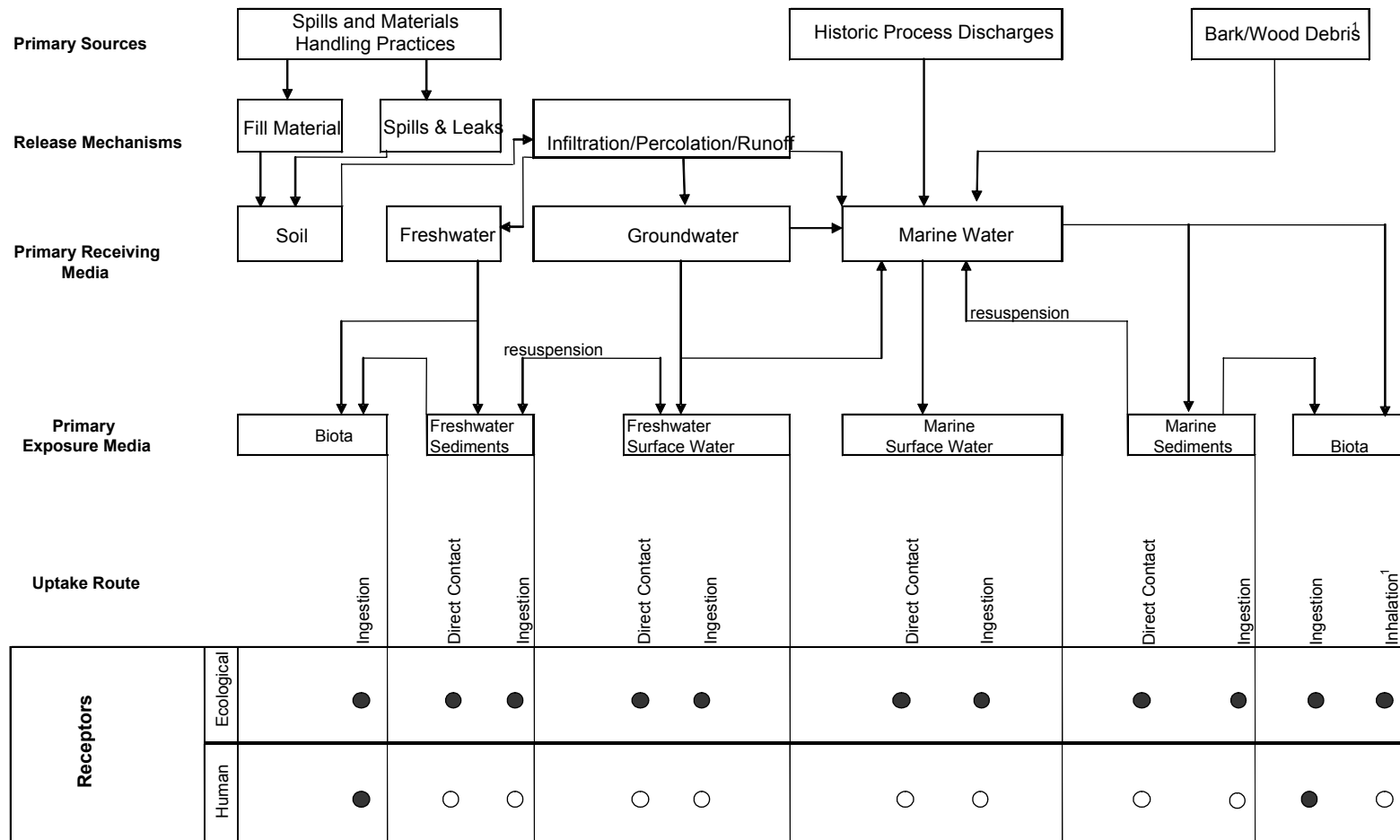


Figure 3-6. Conceptual Site Model for Soil Associated Pathways



- Primary Evaluation Pathway  
○ Secondary Evaluation Pathway

<sup>1</sup>In addition to the effects of chemicals released by wood debris, the CSM also depicts concerns about impacts to biota resulting from the depletion of oxygen in surface and interstitial waters by the wood decomposition process.

**Figure 3-7. Conceptual Site Model for Aquatic Pathways**

### **3.3.2 PRIMARY RELEASE MECHANISMS**

The primary release mechanisms for contaminants potentially present on the terrestrial portion of the former Rayonier Mill Site include the following:

- Contaminated fill
- Accidental spills and leaks
- Stack emissions

Contaminants could have been released to the former Rayonier Mill Site by accidental spills of material during daily plant operations (e.g., dry chemicals, liquid chemicals, fuel, fly ash, and solvents) and by direct ash emissions from the exhaust stacks of the former Rayonier Mill Site boilers. Particulates suspended in stack emissions precipitated onto soils located on the former Rayonier Mill Site and adjacent land. For the aquatic portion of the former Rayonier Mill Site, the primary release mechanisms include the following:

- Accidental spills and leaks
- Stack emissions
- Discharge from permitted NPDES wastewater treatment system outfall (Port Angeles Harbor)
- Discharge from nearshore outfalls

Contaminants released onto the soil from accidental spills, leaks, and stack emissions could potentially migrate to Ennis Creek and Port Angeles Harbor through a variety of transport mechanisms. Five nearshore outfalls discharged mill effluent directly into Port Angeles Harbor from 1930 to 1972. Primary effluent treatment was implemented in 1972 when the discharge was consolidated to one deep-water outfall. Secondary effluent treatment was implemented in 1979 and continued until the plant closure in 1997.

### **3.3.3 PRIMARY TRANSPORT MECHANISMS**

Primary transport mechanisms for contaminants potentially present at the former Rayonier Mill Site include the following:

- Air transport of stack emissions
- Volatilization and wind erosion of chemicals from soil
- Infiltration, percolation, and runoff of chemicals from soil

Particulate and gaseous stack emissions may be transported great distances from the source by the wind. Depending upon particulate sizes and weather conditions, particulate emissions tend to deposit on soil and surfaces of plants and buildings.



Particulates that deposit on surfaces of plants and buildings may bind to the surfaces or be washed off by rain to accumulate in the soil.

Chemicals that accumulate in soils can migrate via several transport mechanisms. Chemicals vary in their water solubility and ability to bind with soil particles. Transport of chemicals in soils can occur via volatilization and wind erosion. Some of the chemicals potentially released at the former Rayonier Mill Site readily volatilize and disperse into ambient air. Wind erosion may disperse chemicals adsorbed onto soil particles into the atmosphere as dust. Transport of chemicals absorbed onto surface soil particles may also occur during storm events through surface water runoff of entrained soil particles. These airborne and waterborne processes could transport chemicals beyond the boundaries of the former Rayonier Mill Site to surrounding land and surface waters.

Chemicals may also desorb from the soil particles into the runoff water and near-surface groundwater. Chemicals dissolved in the runoff water may migrate to Ennis Creek and Port Angeles Harbor. Chemical transport processes in the subsurface soil consist of diffusion and advection processes. These processes are, in part, governed by soil porosity, permeability, and the moisture content of the soils. The diffusion process is dominated by the partitioning of chemicals at the soil and water interface. Once dissolved in the groundwater, chemicals can migrate from the former Rayonier Mill Site into adjacent surface-water bodies. The hydraulic effect of the tidal action and the rewetting of the soil particles at the soil-water interface may cause chemicals, depending on their partitioning coefficient, to desorb from the soil particles at the water interface.

Depending on the permeability of the base material, potential subsurface chemicals that may have leached into the tidal zone influence region could be transported through the material by tidal actions. While the diffusion process, governed by the partitioning of the chemicals at the soil and water interface, is potentially occurring, the transport mechanism is likely dominated by particle entrainment in the tidal water due to physical actions of tidal fluctuations. Thus, particles may be transported through the groundwater to a sediment-water interface in the intertidal zone. Tidal actions may cause the release of the soil particles from the fill matrix into the water. As a result of these mechanisms, chemicals (both dissolved and particulate forms) may be transported to the sediment-water interface of the harbor in the intertidal zone.

### **3.3.4 SECONDARY SOURCES**

Based on the potential physical transport pathways present at the former Rayonier Mill Site, environmental media potentially affected by chemical releases from the former Rayonier Mill Site include air, surface and subsurface soils, near-surface groundwater, and sediments and surface waters in Ennis Creek and Port Angeles Harbor. These media can act as secondary sources that dynamically interact among themselves in terms of chemical migration. They can also act as sources for uptake of chemicals into

plants and animals. Once a chemical is taken up by a plant or animal, it enters a foodweb where it can be transferred to animals at all trophic levels, including man. Chemicals that are highly bioaccumulative pose the greatest concern once they enter a foodweb.

### 3.3.5 POTENTIAL PATHWAY AND EXPOSURE ROUTES

For an exposure pathway to be complete, it must have three components: (1) a source of chemical, (2) an exposure point where contact can occur, and (3) an exposure route by which contact can occur. Potential exposure routes for human and ecological receptors include the following:

- *Dermal/Direct Contact.* Dermal contact with soil on site is a primary route of exposure to current and future on-site workers. It is also a primary pathway of concern for off-site individuals at residences where chemicals were deposited as a result of airborne emissions. Vertebrate wildlife tend to have thick fur coats or feathers which serve as barriers to chemicals that they contact in the soil. However, such wildlife spend a great deal of time grooming, and this leads to an increase in the potential for incidental soil ingestion as noted below. Plants and earthworms are exposed directly to the soil.
- *Inhalation.* Suspended particulates from soil can be transported by air and inhaled by potential on-site and off-site receptors. Emissions of volatile chemicals from soil and groundwater (human receptors only) may also be transported as vapors by air, but are considered to be pathways of secondary concern because, in ambient conditions, such vapors are rapidly diluted and degraded.
- *Ingestion.* Accidental ingestion of chemicals in the soil on site, or in the soil that received particulates from stack emissions off site, and the ingestion of chemicals in terrestrial and marine tissue are primary routes of exposure to both human and ecological receptors.

The following section describes specific exposure pathways of primary concern.

#### 3.3.5.1 Exposure Pathways of Concern

Complete exposure pathways by which chemicals can reach potential receptors include the following:

- *Historical Air Discharges.* Chemicals were emitted from the stacks on the former Rayonier Mill Site at various rates throughout the operations. Many of these chemicals (e.g., sulfur) were volatiles and rapidly dissipated to concentrations that would presently be undetectable in the environment. Other chemicals (e.g., dioxins) are much more persistent and are typically associated with the particulate phase of the emission. As these particulates are emitted, they settle or deposit into the surface soil both on and off site at differing rates according to particle size, wind speed, rainfall, and other environmental factors. Exposure to these

chemicals via ingestion of soil, dermal contact with soil, and particulate inhalation, for both off-site and on-site human receptors, is a primary pathway. Because the off-site area is predominantly urban, exposure to environmental receptors is of secondary concern. Particulate emissions may also be deposited onto surface waters. Chemicals associated with the particulates may be dissolved in the surface water and diluted or remain attached to the particulates where they may settle onto the sediment surface.

- *Spills and Materials Handling Practices.* During mill operations, various materials that were stored directly on unpaved portions of the former Rayonier Mill Site were handled, or were accidentally spilled into soil. Chemicals released as a result of storage practices and accidental spills would first enter either the surface or subsurface soil. Ingestion, dermal contact, and particulate inhalation of these chemicals are complete exposure pathways for on-site workers. Ecological receptors in the riparian and vegetated areas of the former Rayonier Mill Site are also potentially impacted by these exposure pathways.
- *Hydrophilic Chemicals Present in the Soil.* Such chemicals are likely to be transported to the shallow groundwater at this site. Once in groundwater, the chemicals may be transported to freshwater in Ennis Creek or to saltwater in Port Angeles Harbor. The two water bodies are cold throughout the year and have restricted access. Human exposure dermally or through incidental ingestion is, therefore, unlikely to be significant. Dermal contact and incidental ingestion are, therefore, pathways of secondary concern. Dermal contact and ingestion of chemicals by wildlife inhabiting these surface water bodies, as influenced by the groundwater, are primary exposure pathways for further consideration.
- *Marine Discharges.* During the mill operation, process discharges to the marine environment occurred in Port Angeles Harbor. These discharges contained chemicals, many of which were water-soluble. Dilution of chemicals in such a large volume of water would likely lower their concentration to levels that would no longer be detectable in the marine water or the sediments. Other chemicals primarily associated with the particulates in the process discharge may have settled into the sediments in the harbor. As noted above, because of the temperature of the harbor, human exposure to the marine water or the marine sediments is not a primary concern. Because of the salinity, ingestion is also not likely.
- *Water and Sediment.* Exposure to the water and sediments by ecological receptors inhabiting the marine environment is a primary concern, both through direct contact with the two environmental matrices and as incidental ingestion. Chemicals that are lipophilic and reside in the sediments may accumulate in the various marine biota inhabiting the harbor. Consumption of these biota by both higher food chain ecological receptors and humans are exposure pathways of primary concern.

- *Wood and Bark Debris.* The area immediately next to the former Rayonier Mill Site, referred to as the log pond, was used for storing and rafting logs before processing. While rafted, bark and small slivers of wood would fall from the logs during wave action and be deposited on the sediments. Additionally, logs that became soaked with water would also sink to the bottom. As the wood debris, particularly bark, decomposes in the marine environment, it can be a source of persistent chemicals (e.g., tannin, lignin, resin, acid, guaiacol, and phenol) which can have toxic effects on sediment-dwelling organisms at high concentrations. Additionally, nonpersistent chemicals such as ammonia and sulfur are also produced by the decomposition process. While these chemicals typically dissipate rapidly to levels not associated with toxic effects when exposed to the water column, interstitial levels can accumulate to pose a risk to sediment dwelling organisms. Since none of these chemicals is likely to be bioaccumulative, human health risks from wood debris are of secondary concern, but exposure pathways to sediment dwelling organisms in contact with and ingesting the sediments and the interstitial water in this area are of primary concern.

*This page intentionally left blank.*